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THE NEW COLLEGE OF ENGINEERING OF NORTHWESTERN UNIVERSITY

DEDICATORY ADDRESS

THE beautiful new building which you to-day dedicate calls to my mind in contrast a plain old building at my own alma mater, in which my college work was done. The four walls of that building were as barren of architectural adornment as the cotton mills in the near-by village. And so the building had been known to many generations of students as "The Mill."

But in our minds our college building was a grist mill and not a spinning or weaving mill. Our college was not a place for spinning yarns, but for grinding away at our studies. Grinds, on each other or on our instructors, served to lighten and brighten our tasks. We considered ourselves choice wheat, which the old mill was to turn into the finest flour.

Realizing the associations which cluster in my mind around that old building, you will understand that I intend no disrespect if I liken your beautiful new building to a mill. A new mill, added to a large and prosperous manufacturing plant. A new mill to turn out a new product.

A new product, did I say? No, not a new product, but a staple article. There was a time, it is true, within the memory of men still young, when the engineering graduate was a novelty in the market—a novelty which sometimes found eager purchasers but which at other times literally went begging.

That era long ago passed away. Training men for the engineering profession in colleges is no longer an experiment. The engineering graduate is a staple product.

But even staple products are sometimes a

drug in the market. No man builds a mill to produce even such staples as flour or cotton cloth, without carefully examining market conditions. It is fitting, therefore, that we survey the market conditions for engineers. How stand the relations of demand and supply? What sort of engineers are most needed to-day? What grade of flour will you set your mill to grind?

Perhaps I can best picture to you market conditions in the engineering profession if I draw a parallel between the engineer and one of his favorite materials—Portland cement.

A quarter of a century ago, Portland cement was an expensive and little used article—just like the engineer of a somewhat earlier period. The valuable qualities and many uses of Portland cement were little appreciated when it was first introduced. The pioneer engineers suffered in like manner. To-day fifty huge mills are producing Portland cement where there was one a generation ago. So where there were four small struggling schools of engineering in the United States in 1850, there are to-day more than fifty times that number, and many of these schools number their students by hundreds and even by thousands.

Manifestly these huge mills for making Portland cement would not have been erected if the public had not found a use for their product. So also the engineering schools could not have multiplied in number and grown in size as they have done if the public had not found the engineering graduate a useful and valuable member of society. But I am bound to say to you that enterprise in the erection of Portland cement mills has at times outstripped demand, and as a result the cement market has been overstocked. The market for engineers follows quite closely the market for cement, and during the past two years there have been many idle cement mills and idle engineers.

With both the cement mills and the engineers it has been a case of competition, and survival—if not of the fittest, then of those best able to survive. Undoubtedly the increase in cement mills and in engineering schools has had the effect in each case of lowering the price of the product. But it is also true that this low price combined with excellent quality has enormously increased the demand, both the demand for cement and the demand for engineers.

Is the engineering profession overcrowded? Are its members underpaid? If you submit these questions to a jury of engineers, you will, I am sure, receive an affirmative verdict. But I suspect you would have the same sort of answer if you inquired of lawyers concerning the legal profession or of physicians as to the practise of medicine.

It is a fact, nevertheless, that certain changes in our educational system during the past half century have operated to swell the ranks of the engineering profession above that of other professions, and by the competition thus set up have reduced the compensation of engineers.

Half a century ago college education in the United States meant one thing only—the old-time standard course of studies in the classical languages and mathematics, with a smattering of elementary science and theology. With the rapid progress of science and the industrial arts there came about a powerful reaction against this ancient scholastic drill that had so long passed under the name of a liberal education. The demand arose that the college should teach something practical, something that would make the student better fit for his life-work. The answer to this demand on the part of the colleges was the introduction of a great variety of schools and special courses of study. Of all these schools, the

most popular and the most successful unquestionably have been the schools of engineering.

You will hear men blaming the engineering schools for overcrowding the profession. I do not think we can accept that criticism offhand. I grant you it is true that many more men have been graduated from our engineering schools in the past twenty years than can find employment in engineering work; but would it be well for the profession or for the country to have it otherwise? Must we not frankly recognize that of the men who graduate from our engineering schools every year, a very considerable percentage are not fitted by natural ability to become successful engineers?

I have great sympathy for the many individual cases of hardship that result from the overcrowding of the profession. I freely subscribe to the statement that the engineering profession as a whole is not paid in proportion to the responsibility it carries and the useful service that it renders to the community; and yet I can not believe it for the benefit of engineers or of the public to have the paths into the engineering profession made too easy or the rewards for the lower grades of engineering work too great. The older men in the profession can recall times when there were not enough engineers to meet the demand, when any man who knew how to handle a transit could command a good salary as an engineer. Some of the recruits brought in at such times have been an injury to the profession and to the public. An injury to the profession because the work of incompetent men in any profession injures its reputation and limits its chances for profitable employment. An injury to the public because the public has to stand the loss and the disaster that result from engineering incompetence.

It is not, then, a conclusive argument against increase in engineering schools that the profession is overcrowded. I yield to no man in honoring our profession. The best efforts of my life have been devoted to its advancement; but when the question is squarely put whether there are too many engineers, I am obliged to answer, there are none too many good engineers even though there be a surplus of poor ones. If engineers are underpaid, as I believe they are, it is because the public which employs engineers does not yet appreciate how valuable high-class engineering work is. Somebody has defined the engineer as a man who can do with one dollar what any fool can do with two. When all members of the profession appreciate and act on that definition, the public can well afford to pay princely salaries to its engineers. How many millions of dollars do you suppose might be saved annually in the United States if high-class engineering were substituted for mediocre engineering? Let me give you an example in just one single industry: steam power plants for generating electric current. One of the most prominent engineering firms in this country recently authorized the following statement: If good engineering were used in the design and operation of electric stations in the United States, a saving might easily be made of one fourth cent per horsepower hour, and that would have amounted last year to no less than $37,000,000.

I deprecate that competition in the engineering profession which lowers the pay of engineers. Competition in engineering ought not to be in rate of pay but in quality of service. A few days ago I received a letter from an official board asking what would be a proper salary to pay an engineer for taking charge of a piece of hydraulic construction involving an expenditure of a million dollars. I replied

that the salary they should pay ought to depend on the sort of man they secured. If they engaged a man of exceptional ability he would probably save them so much in the cost of the work that they could well afford to pay him twice or thrice what they would pay an ordinary engineer.

I am not here to indict my own profession. Far from it. But every member of it who has reached mature years, held large responsibilities and come in contact with engineers of all sorts in actual work, will confess that a very large amount of work is done poorly that ought to be done well. That many, many millions of dollars are wasted that might be saved by better design, better supervision, better execution. Engineers, let us confess, are not exempt from the frailties of humanity. Some of us are lazy, and will take the easy course and let things run on in the rut of routine rather than make the effort to prepare new designs to meet changed conditions. Some of us are arrant cowards, and rather than run any risks we will spend money like water—so long as it is not our own money. I have seen engineers of this type take credit to themselves for their conservatism, and prate in official reports about the high-class construction they had secured, when the fact was that they had spent thousands where hundreds would have satisfied every requirement.

I am perfectly well aware that there are men who defend that type of engineering. They claim that an engineer's business is only to look after accuracy, strength, permanence and safety in construction; to use only the best materials and accept nothing but the highest class of work. It is engineers of this type who are responsible for the idea, still too commonly held, that to put an engineer in charge of work means a great increase in its cost. If we had less such engineering, there would be a greater demand for engineers.

I am able to give you a personal illustration of the difference between the two types of engineering. Within forty-eight hours I have talked with men in Washington who know of the work your director has done there in a great government department of engineering work. He had the good sense to see that this work was only a means to an end, and that accuracy and hair-splitting refinement were only valuable where they were effective in the final result. He solved the problem, "What is worth while," and his solution has saved to the government tens of thousands and probably hundreds of thousands of dollars.

I want to see more engineers who are able to wisely solve this problem, "What is worth while," in a hundred lines of engineering work.

How many hundreds of millions of dollars do you suppose are expended annually in the United States in the promotion of foolish and absurd inventions or enterprises wrongly planned? It has long been a theory of mine that people ought to be saved from losing their money in such schemes by seeking the advice of engineers. But I have found that before my theory can be put into practise, we must have engineers who are wise enough and broad enough to give reliable advice on such matters. And the public must learn to discriminate between the engineers who know and those who only think they know.

I think it well to set forth these facts here for the encouragement of those who may be looking forward to the profession and who may have the feeling that engineering work has already reached such a stage of perfection that there is no room in it for further advancement or greater achievements. There *is* room and need today for better engineers and for a higher grade of engineering work.

And so your mill, although it is to grind out a staple product, is not designed to

undersell the market. You are not aiming merely to increase the output of engineering graduates. Your president has clearly emphasized in his address that it is not cheap engineers but better engineering that the public needs.

Magnificent work has been done for the engineering profession by our colleges. I believe our American system of training men for the engineering profession is far in advance of that in vogue in any other country. We must recognize, however, that the rapid changes in science and industry and engineering make changes necessary in our engineering schools. Imagine a boy to-day taking the course of study that was required at the Rensselaer Polytechnic Institute sixty years ago, and then going out to do engineering work. A high-school graduate of 1909 would be in many ways better equipped.

Go back only a quarter of a century and you will find that the engineering courses then in vogue would not suit present-day requirements. It is no argument for those courses that men who graduated from them have achieved eminence in the profession. Many men who were denied all educational advantages have become great by sheer ability.

So we face the question, What education shall the engineering college give to its students to-day that shall best fit them to win success in their profession?

I have called your institution a mill which is to turn raw material into a finished product. Well, it is raw, sure enough, but let us remember that the material is alive—and let us hope very much alive. I believe, after all, your college is not a mill, but—begging the pardon of the freshman class—a greenhouse.

Engineering education, like any other education worthy of the name, is a process of growth. To achieve success in your greenhouse culture you must have the right sort of plants to start with. Unless a boy has natural abilities of the right sort you can not make him into a good engineer.

On the other hand, boys with good natural abilities who can not afford a college training are going out into the working world all the time, beginning at the bottom rung of the ladder in some line of engineering industry, educating themselves in the school of daily experience, aiding that development by study in night schools and correspondence schools and by wide reading and observation.

I want to leave a wide door open into the engineering profession for the men who obtain their education in such a way. I want to deprecate any petty prejudice on the part of college-trained engineers against the engineers who have won success despite their lack of systematic college training. Such prejudice is as unworthy as that with which the so-called "practical" man met the engineering graduates of a quarter century ago.

The engineering colleges to-day must recognize the aids that are now available to the boys outside of the college, in the shape of the correspondence schools, for example. The question is, How shall the boy who spends four years or five years in the college achieve such growth that he can excel in competition the boy who has meanwhile been learning engineering by doing practical work.

For the past twenty years, the engineering colleges of the United States have been trying to answer this question by specializing their instruction in engineering, by multiplying the number of their courses, by trying to make men expert in one particular limited branch of engineering work. Now I am far from denying that there is a large demand and a certain field of usefulness for such special courses; but I believe the consensus of opinion among those best able to judge is that there has been too

much specialization in our engineering instruction. We have to-day in the engineering profession many specialists, but too few men with broad knowledge, broad abilities and a broad outlook.

One common defect in your self-taught engineer is that, however proficient he may be in the one field where he has had experience, he knows little outside that field. It is the lot of most engineers to change their occupation many times in the course of a lifetime. One branch of engineering work falls off and they are obliged to turn to another. It is the advantage of the man with the broad college training that he can do this with facility. The specialist, however, when work in his specialty fails, finds his occupation gone.

Perhaps the error which is most to blame for the specialization in our college courses is the error that the college education in engineering produces an engineer. The engineering graduate when he leaves the college halls is not yet an engineer, and would not be one even if you doubled the length of your course. There are indeed exceptions. An occasional young man of great ability and with a practical bent of mind will get enough out of his college course, supplemented by wide reading and vacation work, to be fit for considerable responsibility at graduation. But such exceptions only prove the rule. The college course in engineering is only laying a foundation on which the finished superstructure is to be erected through accumulated experience in actual work.

Now it may seem to some of you students a little disappointing to spend four or five valuable years and then only succeed in laying the foundation to become an engineer. But I want to assure you that it is in this very matter of foundation that the college-trained engineer has an advantage over his professional brother who "picks up" engineering. With a broad and deep foundation, there is no limit to the size of your superstructure and no limit to the speed with which you may erect it.

But the boy who starts in at engineering work when he leaves the common school is like one erecting a building and putting the foundation under it as he goes along. The job is not impossible, given patience and perseverance enough, but it takes a lot of both. Progress is slow, and the chances are that the man will be satisfied finally with a modest structure. Besides, foundations put in in this way are never quite as strong, never quite as reliable, as those built in the regular way. Sometimes such foundations fail and down comes the building.

The business of the engineering college, then, is to lay a broad, secure foundation. I am not objecting, mark you, to schools of a different sort. There is room and need for correspondence schools, for night schools, for industrial schools, for schools that may give special instruction in special fields. But if you aim to give an education to young men that will best fit them for high and responsible positions in the engineering world, then you must make your training a broad foundation.

And let me carry the simile one step further. You will find great difficulty in laying a secure foundation in a deep swamp or in fathomless quicksand. It will be a far better foundation if underlaid by rock or hardpan. So if you want to build a good foundation of engineering education, you must have to start with a boy of proper mental and moral and physical make-up. Now how will you restrict your work to such boys? That is, I think, one of the most difficult problems which our American colleges have to solve.

They are trying to solve this problem by raising their entrance requirements. They are trying to solve the other problem, how they may send out only high-class men into

the profession, by increasing the work of the college course. These are probably necessary changes; and yet I want to sound one note of warning:

There is danger, I believe—and I am not alone in this belief—that you may shut out of your engineering courses boys who have natural abilities which fit them for success as engineers and yet are deficient in some branch of study, perhaps mathematics or the languages.

I do not underestimate the value to an engineer of either of these branches; yet I feel that they have been often overestimated in the framing of our engineering courses.

There is danger, if you place your emphasis too much on purely scholastic attainments in your engineering schools, that you may raise up a generation of scholastic engineers, expert in theory but weak in its practical application. The mathematical side of the profession and even the research laboratory have been, if anything, overdone already. We must lay broader foundations than these typify if your graduate is to successfully compete with his rival, educated in the school of hard knocks. A broader training than this is needed if your engineer graduates are to meet the demands of this twentieth century.

Do you say, what are these demands? I want to impress upon you that the country to-day needs engineers of high type as it never has needed them before. Few realize the enormous change that has taken place in the relations between the engineer and the public. Go back less than a century—no longer ago than the lifetime of men still living—and you find the engineer almost unknown. Civilization and industry knew his prototype—the millwright, the builder, the miner; but their art was the art handed down by tradition, crusted over with superstition and error. The application of science and the scientific method to industry had barely begun.

Go back half a century and we have the beginnings of engineering: the railway, the steamship, the development of the mine and the waterfall. There were great men among the engineers of those pioneer days. We do well to honor their achievements. Yet the problems of that day, seen in our present light, were simple. The engineer was a necessity in very few industries. His art was not yet so complicated that it could not be mastered by the diligent student with little aid in the way of text-book or teacher.

But the period since the civil war, and particularly the latter half of that period, have seen social, economic and industrial revolutions, such as the world has never before witnessed. Civilization finds itself face to face with a multitude of perplexing problems. And a very large number of these problems are so interwoven with our industrial development that the engineer is needed to aid in their solution.

I have told you that engineers are needed to effectually solve the problem, "What is worth while." Is it worth while to spend two hundred million dollars to build one kind of lock canal at Panama, or three hundred million dollars to build the one we are now completing, or five or six hundred millions to build a sea-level canal? Is it worth while for the government to spend half a billion dollars on waterway improvements? Is it worth while for a state to spend a million or ten millions on good roads? How much ought a city to spend on sewage disposal, on the purification of its water supply, on lighting its streets?

I know engineers who shirk these questions, who say that the engineer should take a humble back seat while the statesman, the lawyer, and—if you please—the ward alderman decide these questions.

I tell you, gentlemen, this is a huge mis-

take. Our statesmen and lawyers and aldermen—even when they are honest and well-meaning—are sadly lacking in knowledge, except it be that little knowledge which is proverbially so dangerous.

For lack of wise engineering leadership the public is being led to-day toward many an unwise and wasteful expenditure. Men are going up and down the land to-day fostering fallacies and errors—errors which will directly affect our national welfare unless good sense and good judgment can be invoked to correct them.

No student of history can fail to be impressed with the importance to a people of able leaders. The prosperity of our own favored nation rests no more certainly on natural resources and on an intelligent and law-abiding people than it rests on wise leadership. The opportunity for leadership is open to the engineer. His technical knowledge is essential to the wise solution of public problems. Can he couple with his technical knowledge those other qualities which are essential if the public is to be safely guided?

And what are some of the qualities? Well, I would name first of all what I may term the judicial spirit. An engineer has no business to be governed by prejudice or partisanship. His sole object ought to be to find where the truth lies. He must constantly make choices in his daily work, and sound judgment in such choices is a first requisite. Of course he must have the knowledge on which to base a judgment; and yet when I am asked to recommend an engineer for large responsibilities, I look first of all for a man of broad mind, one who is able to weigh matters fairly and judge without prejudice. Even though such a man be compelled to rely on others for some part of the technical knowledge required, he is a safer counselor by far than a man of small caliber, though the latter be loaded to the muzzle with facts and theories.

The public has some reason for distrusting the judgment of so-called experts. If your expert has been a man of one idea too long, there is danger that his grasp of broad principles may be deficient and that his judgment may be warped.

Can you develop in your students who go out from this institution those qualities of mind and heart and character which will in later years ripen into sound judgment? If they gain such development from their college training they will gain something much more rare and valuable than knowledge of hydraulics or expertness in the testing laboratory.

Does it seem to you impossible to cultivate in your college course such personal qualities as the judicial spirit? I grant you that a proper mental equipment in the student is essential at the start; but given that, ought not the college years—the formative period of a man's life—to be effective in cultivating just such qualities? Do not our American colleges and universities miss their highest opportunity if they fail to develop in their students a broad outlook, fair-mindedness, keenness to discern error, love of the truth?

I have emphasized the need of engineering leadership. But the essential to leadership is the ability to deal with men. Your engineer may be a master of professional knowledge. He may have even the good judgment necessary for its application; but if he can not meet men face to face and hold his own with them, his professional ability will not win him the highest success.

Every engineer of long experience knows that the ability to write a clear report or a strong letter, to speak forcibly and convincingly, either to one man alone or an audience of hundreds—ability to do things like these is as valuable to an engineer as technical knowledge. Training in writing and in speaking is being emphasized more and more in our engineering courses.

And there are other qualities that make for leadership: tact—the combination of good judgment with good taste in dealing with others; self-confidence without self-conceit; a personality that attracts men, wins their confidence, holds their loyalty. It is qualities such as these that make the leader of men. It is such choice qualities as these that the atmosphere of our universities ought to develop in their students. Was it not with such high ends in view that our universities were founded?

Your splendid new building has higher purposes than a mere mill. You will not rate its success in dollars and cents of annual profit. And I want to protest against the too common standard by which we rate the success of men. You tell me that this graduate holds a $25,000 position, that another owns a rich copper mine and a third is president of a colossal trust. Have they achieved success? Very likely; but why not apply to them the same standard that we apply to your university?

The true measure of success, alike for the university and for its graduates, is the test of public service.

I know an engineer who has through long years guided the destinies of a great city, saved to its taxpayers untold millions of dollars, fostered its development in a way that will benefit generations yet unborn.

I know an engineer who dared to risk his professional reputation and his life to uncover fraud upon the commonwealth and to punish the guilty.

I know an engineer who has turned a barren desert into fruitful farms, has made possible prosperity and happiness to thousands and tens of thousands.

It is true that the public seldom appreciates the value of such services as these, and those who render such service often receive only meager reward; and yet I tell you that it is achievements like these that best deserve the name of success.

Shall we not then dedicate your new building to the culture of such high ideals? Within its walls may all noble traditions, all honorable standards, be fostered and upheld. May those who go forth from its influences carry with them a rich spirit of loyalty—loyalty to the public welfare, loyalty to their city, their commonwealth, their country. So will they justify those who to-day dedicate this building to public service.

CHARLES WHITING BAKER

THE NEW COLLEGE OF ENGINEERING, AN OPPORTUNITY[1]

A GREAT opportunity is before us. Through the generosity of Mrs. G. F. Swift and Mr. Edward F. Swift an excellent building for the new College of Engineering has been erected and its maintenance provided for. The board of trustees has determined to furnish the necessary funds to develop the new college. It will start with all the advantages, and they are many and not easily measured, of being a new department of an old and prosperous university, rather than a new, separate organization. Those persons at Northwestern who have fostered for years the idea that engineering should be taught at this university have had high ideals for the new college which have already helped it. The position of the new College of Engineering, within easy reach of one of the greatest centers of commerce and industry in the world, will furnish its students and professors unusual opportunities to keep in touch with the practising engineer. The new College of Engineering is being started at a time when the methods of engineering education are rapidly changing and developing. This is, therefore, an opportune time for it, if properly guided, to take and

[1] Address delivered at the dedication of the new College of Engineering of Northwestern University by the director-elect.